भारतीय मानक

Indian Standard

IS 18433 (Part 1) : 2023

सतही घर्षण गुणधर्म का मापन — परीक्षण पद्धतियाँ

भाग 1 पेंडुलम विधि

Measurement of Surface Frictional Properties — Methods of Test

Part 1 Pendulum Test

ICS 13.340.60

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October 2023 **Price Group 6**

Flooring, Wall Finishing and Roofing Sectional Committee, CED 05

FOREWORD

This Indian Standard (Part 1) was adopted by the Bureau of Indian Standards, after the draft finalized by the Flooring, Wall Finishing and Roofing Sectional committee had been approved by the Civil Engineering Division Council.

The selection of any type of floor surface finish for use at home or at commercial space (especially in industry) is very much important. One of the selection criteria involves frictional properties of the tile surface. Frictional resistance can be measure by various methods. One of the method described in this standard in pendulum test method. The other standard in this series is:

Part 2 Ramp Test

This test method provides a measure of the frictional property, micro-texture of surfaces, either in the field or in the laboratory. The method may also be used to determine the relative effects of various polishing processes on materials or material combinations.

While formulating this standard, considerable assistance was derived from ASTM E303-93 ‘Standard test method for measuring surface frictional properties using the British pendulum tester’.

The composition of the Committee responsible for the formulation of this standard is given in Annex B.

This standard contributes to the United Nations Sustainable Development Goal 9 ‘Industry, innovation and infrastructure, build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation’.

In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'.

Indian Standard

MEASUREMENT OF SURFACE FRICTIONAL PROPERTIES — METHODS OF TEST

PART 1 PENDULUM TEST

1 SCOPE

1.1 This test method covers the procedure for measuring surface frictional properties using the pendulum skid resistance tester.

1.2 This test is deemed suitable for all surfaces except highly structural/profiled surfaces. For structured surfaces, the ramp test shall be referred.

1.3 This test method can be used to assess and classify floor surfaces based on their pendulum test number (PTN) values (which indirectly indicate their slip resistance). The finishing layer (for example, tiles, stone, paver block, etc) of a particular floor is to be tested.

2 REFERENCES

The standards given below contains provisions, which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of these standards:

IS No.	*Title*
IS 4588 : 1986	Specification for rubber, raw, natural
IS 18433 (Part 2) : 2023	Measurement of surface frictional properties — Method of test: Part 2 Ramp Test

3 TERMINOLOGY

For the purpose of this standard, the following definitions and terms shall apply.

3.1 Pendulum Tester — A dynamic pendulum impact-type tester used to measure the energy loss when a rubber slider edge is propelled over a test surface. The tester is suited for laboratory as well as field tests on flat surfaces.

3.2 Pendulum Test Number (PTN) — A number that represents the frictional properties obtained with the apparatus and the procedures stated herein and do not necessarily agree or correlate with other slipperiness measuring equipment.

3.3 Drag Pointer — A pointer attached to the pendulum which indicates the PTN value of the surface being tested. The greater the friction between the pendulum slider and the surface being tested, the more the swing of the pendulum is retarded, and the larger the PTN reading.

3.4 Slip Potential — Tendency of a surface towards slippage. High slip potential indicates greater susceptibility of slippage during day to day use. Surfaces with greater slip potential will have lower PTN values.

4 SIGNIFICANCE AND USE

4.1 This test method provides a measure of a frictional property, micro-texture of surfaces, either in the field or in the laboratory.

4.2 This test method may be used to determine the relative effects of various polishing processes on materials or material combinations.

4.3 The values measured in accordance with the method do not necessarily agree or directly correlate with those obtained utilizing other methods of determining friction properties or skid resistance.

5 APPARATUS

5.1 Pendulum Tester (*see* Fig. 1)

The pendulum with slider and slider mount shall weight 1 500 g ± 30 g. The distance of the centre of gravity of the pendulum from the centre of oscillation shall be 411 mm ± 5 mm. The tester shall be capable of vertical adjustment to provide a slider contact path of 125 mm ± 1.6 mm for tests on flat surfaces. A method for calibration of the tester is included in Annex A.

The spring and lever arrangement shown in Fig. 2 shall give an average normal slider load between the 76 mm wide slider and test surface of 2 500 g ± 100 g, as measured by the method prescribed in Annex A.

5.2 Slider

The slider assembly shall consist of an aluminium backing plate to which is bonded a 6 mm × 25 mm × 76 mm rubber strip for testing flat surfaces. The rubber compound shall be natural rubber meeting the requirements of IS 4588, or synthetic rubber. The shore hardness of the rubber should be in the range 55 to 61.

5.2.1 New sliders shall be conditioned prior to use by making ten swings on No. 60 grade silicon carbide cloth or equivalent under dry conditions. The swings shall be made with a tester adjusted as in **7**.

5.2.2 Wear on the striking edge of the slider shall not exceed 3.2 mm in the plane of the slider or 1.6 mm vertical to its plane, as illustrated in Fig. 3.

5.3 Accessories

5.3.1 Contact path gauge shall consist of a thin ruler, suitably marked for measuring contact path length between 124 mm to 127 mm.

5.3.2 Miscellaneous equipment, such as water container, surface thermometer, and brush are recommended.

6 TEST SPECIMEN

6.1 Field or Larger Surface

Field test surface shall be free of loose particles and flushed with clean water. The test surface does not have to be horizontal, provided the instrument can be levelled in working position using only the levelling screws and the pendulum head will clear the surface.

6.2 Laboratory

Laboratory test panels shall be clean and free of loose particles and shall be held rigidly with appropriate locking mechanism so as not to be moved by the force of the pendulum. Laboratory test panels shall have a test surface of at least 89 mm × 152 mm.

7 PREPARATION OF APPARATUS

7.1 Levelling

Level the instrument accurately by turning levelling screws unit the bubble is centered in the spirit level.

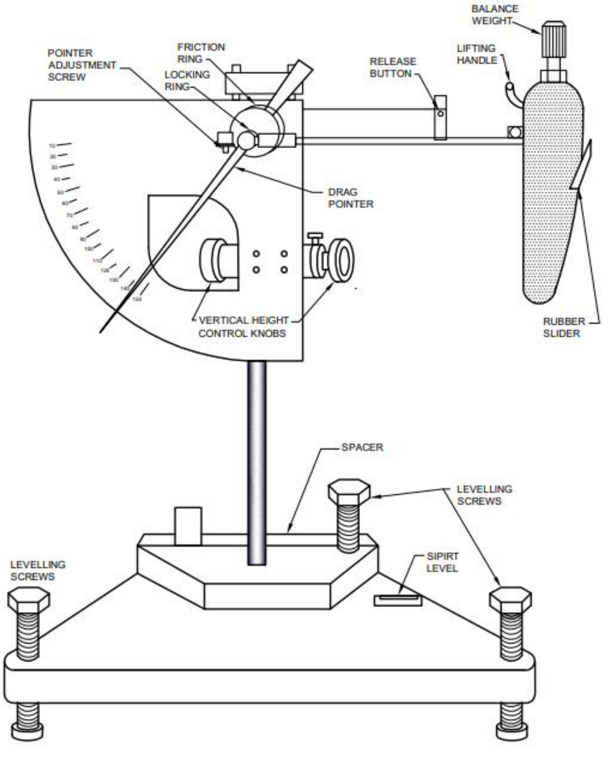

FIG. 1 PENDULUM TESTER

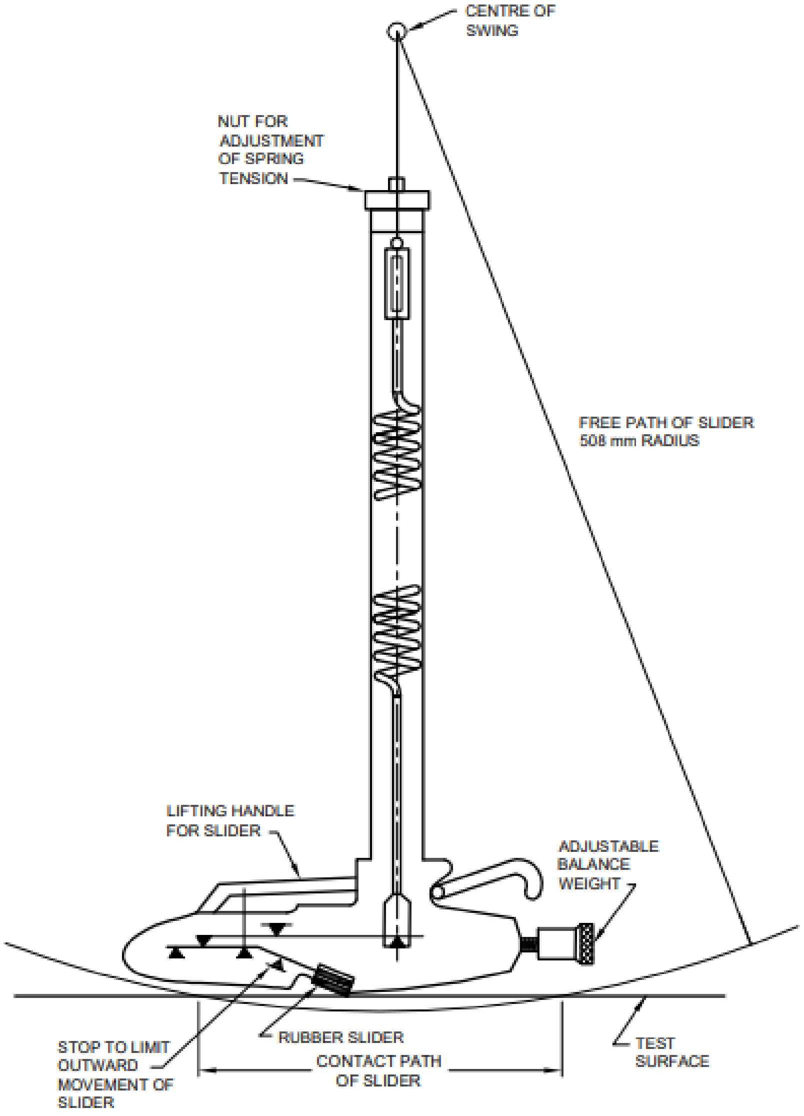
CENTRE OF SWING
NUT FOR ADJUSTMENT OF SPRING TENSION
FREE PATH OF SLIDER 508 mm RADIUS
LIFTING HANDLE FOR SLIDER
ADJUSTABLE BALANCE WEIGHT
STOP TO LIMIT OUTWARD MOVEMENT OF SLIDER
RUBBER SLIDER
CONTACT PATH OF SLIDER
TEST SURFACE

FIG. 2 SCHEMATIC DRAWING OF PENDULUM SHOWING SPRING AND LEVER ARRANGEMENT

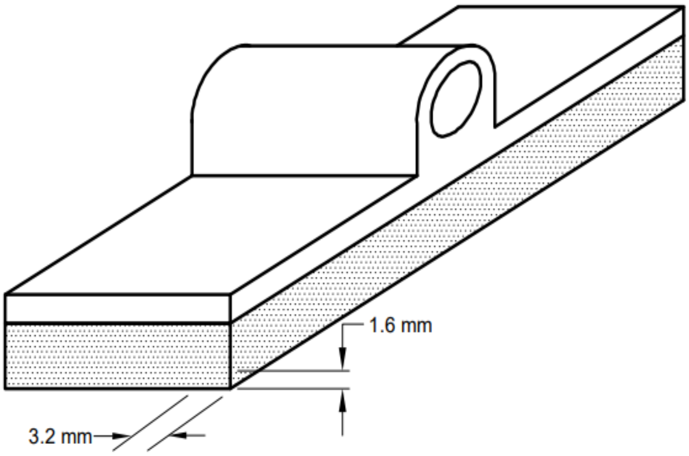

FIG. 3 SLIDER ASSEMBLY ILLUSTRATING THE MAXIMUM WEAR ON STRIKING EDGE

7.2 Zero Adjustment

Raise pendulum mechanism by loosening locking knob (directly behind pendulum pivot) and turn either of pair of head movement knobs at centre of tester to allow slider to swing free of test surface. Tighten locking knob firmly. Place the pendulum in release position and rotate the drag pointer counter clockwise until it comes to rest against adjustment screw on the pendulum arm. Release the pendulum and note the pointer reading. If the reading is not zero, loosen locking ring and rotate friction ring on bearing spindle slightly and lock again. Repeat test and adjust friction ring until the pendulum swing carries pointer to zero.

7.3 Slide Length Adjustment

7.3.1 With pendulum hanging free, place spacer under adjusting screw of lifting handle. Lower the pendulum such that the edge of slider just touches the surface. Lock pendulum head firmly, raise lifting handle, and remove spacer.

7.3.2 Raise slider by lifting handle, move pendulum to right, lower the slider and allow the pendulum to move slowly to left until edge of slider touches surface. Place gauge besides the slider and parallel to direction of swing to verify the length of contact path. Raise slider, using lifting handle, and move the pendulum to left, then slowly lower until slider edge again comes to rest on surface. If the length of the contact path is not between 124 mm to 127 mm on flat test specimens, measured from trailing edge to trailing edge of the rubber slide, adjust by raising or lowering instrument with the front levelling screws. Re-adjust level of instrument if necessary. Place pendulum in release position and rotate the drag pointer counter-clockwise until it comes to rest against adjustment screw on pendulum arm.

8 PROCEDURE

8.1 Apply sufficient water to cover the test area thoroughly. Execute one swing, but do not record reading.

NOTE — Always catch the pendulum during the early portion of its return swing. While returning the pendulum to its starting position, raise the slider with its lifting handle to prevent contact between the slider and the test surface. Prior to each swing, the pointer should be returned until it rests against the adjustment screw.

8.2 Without delay, make four more swings, re-wetting the test area each time, and record the results.

NOTES

1 Care should be taken that the slider remains parallel to the test surface during the swings, and does not rotate so that one end rather than the entire striking edge makes and initial contact. Available data indicates that tilting of the slider may cause erroneous PTN readings.

2 Installation of a small, flat spring will relieve the problem. The spring can be inserted into a slot in the spring clip and the assembly secured by the cotter pin as shown in Fig. 4. The free ends of the spring can rest on the slider backing plate to restrain the slider from tilting.

8.3 Recheck the side contact length in accordance with **5.3**.

9 REPORT

Report the following information:

a) Individual values of PTN;
b) Temperature of the test surface;
c) Type, age, condition, texture, and location of test surface; and
d) Type and age of the rubber slider.

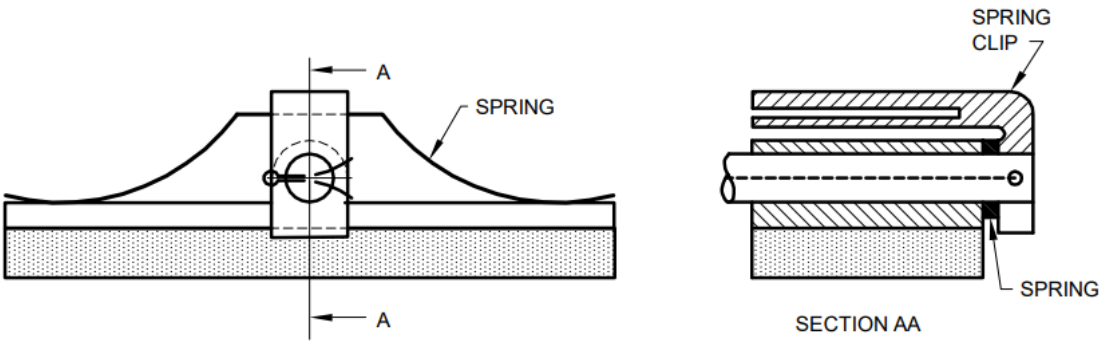

FIG. 4 SPRING CLIP AND SPRING TO INHIBIT SLIDER ROTATION

10 PRECISION AND BIAS OF PTN UNITS

10.1 Repeated tests show a standard deviation of 1.2 PTN units when conforming rubber sliders are used.

10.2 The relationship, if any exists, of observed PTN units to some 'true' value of skid resistance has not and probably cannot be studied. As a result, precision and bias of this test in relation to a true skid resistance measure cannot be evaluated, and only repeatability is given for the method.

10.3 Determine the testing error as follows:

$$E = t\frac{\sigma}{\sqrt{n}}$$

where

E = testing error;

t = normal curve of 1.96 or 2.0 rounded;

σ = standard deviation of individual test results (PTN units); and

n = number of tests.

10.4 In order to ensure that the testing error stays within 1.0 PTN unit at a 95 percent confidence level (corresponding to a normal curve of 1.96 or 2.0 rounded), a sample size of 4 for natural rubber sliders and 5 for synthetic rubber sliders are required.

11 CLASSIFICATION OF SURFACE BASED ON TEST RESULTS

11.1 The surfaces being tested shall be classified and interpreted as given in Table 1, based on the measured PTN values. Table 1 also mentions typical floor application areas with respect to the slip potential of the surface.

11.2 A general correlation of the PTN value with the slip resistance classified by the ramp test (R value) [*see* IS 18433 (Part 2)] for same surfaces can be considered as shown in Table 2. However, these correlations should be ascertained for initially unknown surfaces and should not be used for cases where the pendulum test has limitations, as mentioned in the scope of this standard.

Table 1 Classification of Slip Potential of the Surface and Typical Applications

(*Clause* 11.1)

Sl No. (1)	Slip Potential of the Surface (2)	PTN Value (3)	Typical Floor Applications (4)
i)	High	Up to 24	Low risk internal applications, customer reception areas, toilet and bathroom areas, self-service cafeterias, cold stores, dish washing areas
ii)	Moderate	25 to 35	Liquid spillage areas, large commercial kitchens
iii)	Low	Greater than 35	High risk of slip, oil spillage or similar present

Table 2 Correlation of PTN and R Values

(*Clause* 11.2)

Sl No. (1)	Slip Potential (Based on PTN Value) (2)	Slip Resistance (Based on R Value) (3)
i)	High	R9-R11
ii)	Moderate	R12
iii)	Low	R13

ANNEX A

(*Clause* 5.1)

METHOD FOR CALIBRATION

A-1 CALIBRATION

A-1.1 Weight of Pendulum

The pendulum arm with mounted rubber slider shall be disconnected from the instrument weighed to the nearest 1 g.

A-1.2 Centre of Gravity

The centre of gravity of the pendulum with a mounted rubber slider shall be determined by placing the pendulum assembly over a knife edge and experimentally locating the point of balance as shown in Fig. 5.

The adapter nut shall be held at the far end of the arm by a light paper wedge. After the point of balance has been obtained, the position of the balance weight shall be adjusted until the slides of the pendulum foot are horizontal.

A-1.3 Distance of Centre of Gravity from Centre of Oscillation

With the pendulum reconnected to the tester and knurled bearing cap removed, distance shall be measured from the centre of oscillation (centre of bearing nut) to the point of balance (centre to gravity). This distance shall be measured directly to the nearest 1 mm.

A-1.4 Slider Load

The pendulum shall be clamped to a holder attached to the scale plate of the tester, and the tester placed and levelled on a tripod stand. Insert the spacer and adjust the pan balance with a bearing assembly (*see* Note 1) on one pan and tare weights on the other pan so that the balance pointer is at centre scale reading. The pendulum, with a slider, shall be lowered with the vertical height knobs of the tester until the slider is approximately 0.25 mm from the top surface of the bearing assembly. Lock vertical height knob and remove the spacer. This will cause an unbalance which shall be partially compensated by adding weights to the opposite pan to bring the indicator to within approximately 200 g of the centre scale reading. To complete the balance procedure, the pointer is returned to the centre scale reading by adding water slowly into a graduated cylinder. Empty the cylinder and repeat pouring. Record the average weight required to raise slider so that the balance pointer is at the centre of scale (*see* Note 2). If the average, normal slider load between the 76 mm wide slider and the pan balance is not within the requirements stated in **5.1**, adjust the spring tension nut illustrated in Fig. 2 and re-determine the slider load.

NOTES

1 The bearing assembly may be a 'ladder' bearing with a rigid, free moving top plate or a similar arrangement so that no horizontal loads are introduced while measuring the vertical slider load.

2 It may be necessary to move the pans of the balance up and down to 'work' the spring in order to get smooth and consistent reading. If the measurements of the slider load are still irregular after 'working' the spring, remove the slide and bottom panels of the pendulum foot and inspect for cleanliness of the bearing surfaces and knife edges and re-determine the slider load.

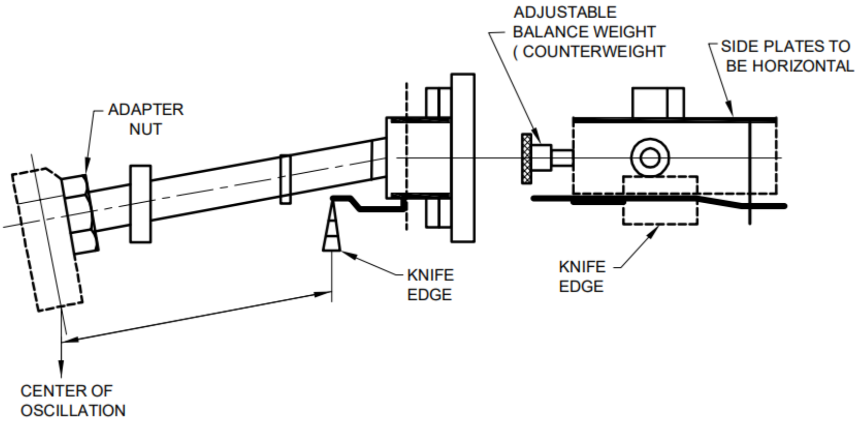
ADJUSTABLE BALANCE WEIGHT (COUNTERWEIGHT
SIDE PLATES TO BE HORIZONTAL
ADAPTER NUT
KNIFE EDGE
KNIFE EDGE
CENTER OF OSCILLATION

FIG. 5 PENDULUM ASSEMBLY SHOWING LOCATION OF THE POINT OF BALANCE

ANNEX B

(*Foreword*)

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Amend No.	Date of Issue	Text Affected

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